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F01 Exterior Lighting

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Exterior Lighting

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Understand the function of the Exterior lighting of the F01/F02
- Understand the functions of the adaptive headlights on the F01/F02

Introduction

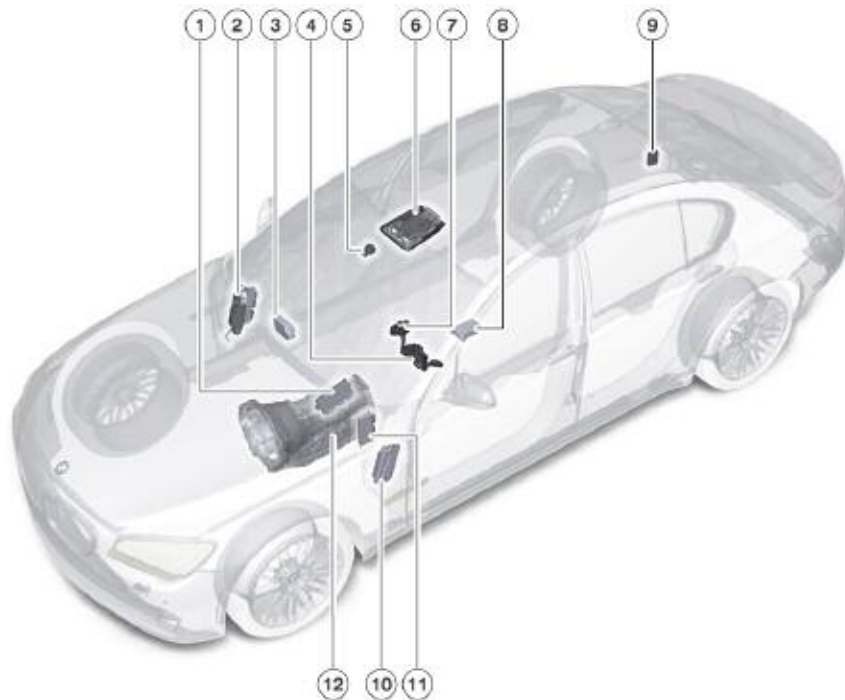
Comprehensive Exterior Lighting Systems

The following information outlines the function of the exterior lighting system and the adaptive headlights. The F01/F02 are equipped with standard adaptive headlights.

The F01/F02 features the welcome light, making the vehicle even more customer friendly. The exterior lighting system is switched on for approximately 20 seconds when the vehicle is unlocked. This has the advantage of locating the vehicle more easily under unfavorable light conditions.

A further feature is the daytime driving light that can be activated or deactivated via the Personal Profile.

Control units for the exterior lighting system F01/F02



Index	Explanation	Index	Explanation
1	Car Access System	7	Controller
2	Junction box electronics	8	Integrated chassis management
3	Crash safety module	9	Trailer module
4	Steering column switch cluster	10	Footwell module
5	Rain/light/solar/condensation sensor	11	Central gateway module
6	Roof functions center	12	Electronic transmission control

Exterior Lighting System with Adaptive Headlights

The adaptive headlights include the functions of the exterior lighting system. However it allows panning of the bi-xenon low-beam and high-beam headlights when cornering.

Note: Standard equipment for the vehicle includes bi-xenon headlights, fog lights and automatic driving lights function.

Panning of the bi-xenon low-beam and high-beam headlights is adapted continuously during cornering. Illumination during cornering therefore improves the driver's vision.

Illumination during cornering results in:

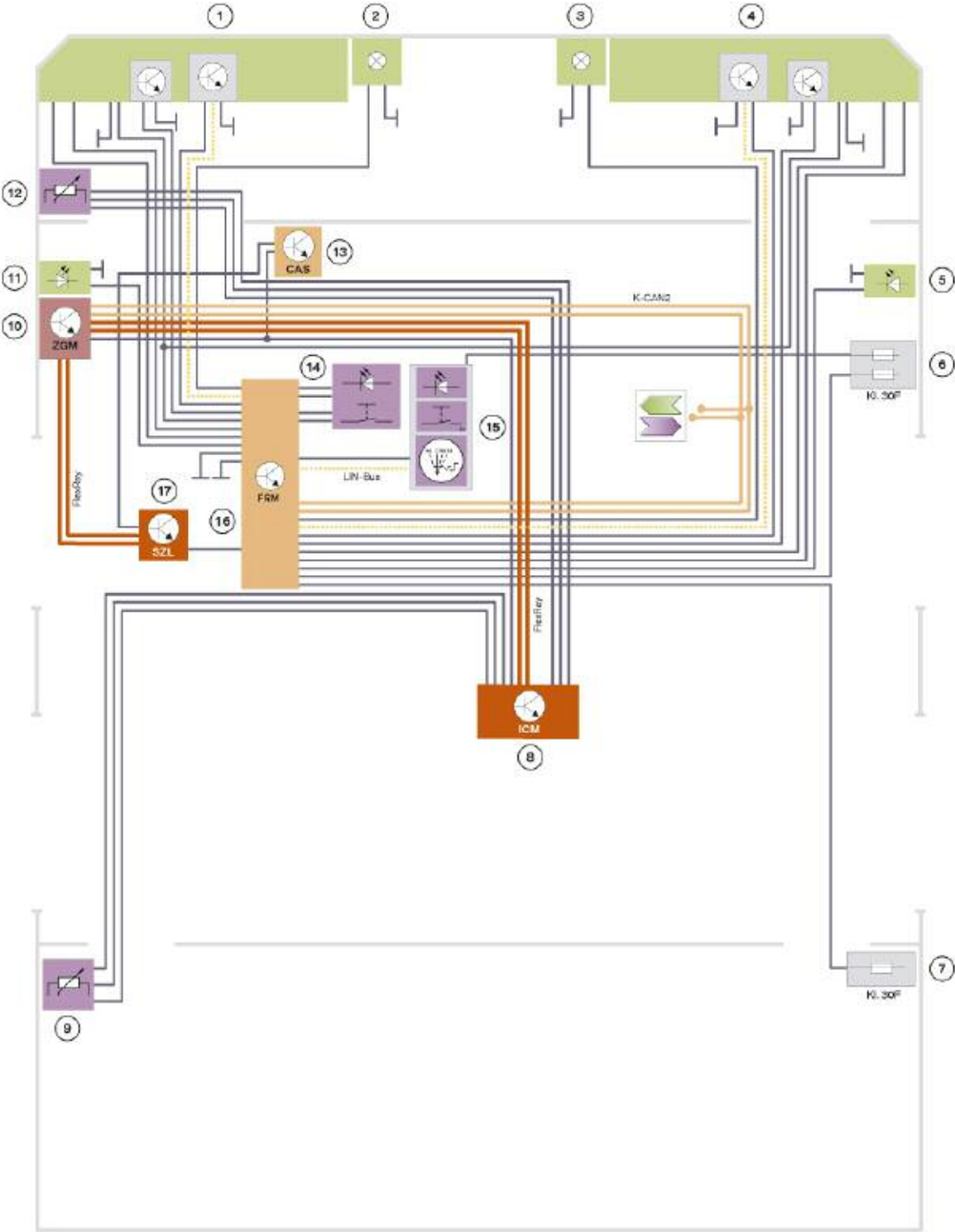
- Safer cornering with faster identification of obstacles
- Better perception of the environment
- Prevention of accidents.

The electronics of the adaptive headlight allow fast reaction to the current driving conditions. The system is controlled by the electronics and is less susceptible to malfunctions than purely mechanical systems.

Furthermore an emergency program can be activated via the electronics.

System Overview

Schematic Circuit Diagram - Exterior Lighting System, Front



Index	Explanation	Index	Explanation
1	Main headlight, left	12	Ride-height sensor, front
2	Front fog light, left	13	Car Access System (CAS)
3	Front fog light, right	14	Hazard warning lights switch
4	Main headlight, right	15	Control panel, light switch
5	Direction indicator repeater, right	16	Footwell module FRM
6	Power distribution box, front	17	Steering column switch cluster SZL
7	Power distribution box, luggage compartment	K-CAN2	Body CAN2
8	Integrated Chassis Management ICM	FlexRay	FlexRay
9	Ride-height sensor, rear	LIN-Bus	Local interconnect network bus
10	Central gateway module ZGM	KL. 30F	Terminal 30, fault switched
11	Direction indicator repeater, left		



K-CAN2 signals at footwell module

In/Out	Information	Sender/Receiver	Function
In	Crash signal	Crash sensor > Crash safety module	Interior lighting ON, hazard warning lights ON, Terminal 58g ON
In	Status, trailer module	Trailer socket outlet > trailer module	Trailer lighting
In	Outside temperature	Outside temperature sensor > instrument cluster	Outside temperature for calculation of the headlight overheating protection
In	Delayed switch-off home lights	Controller > Central information display	Switch-on time for the home lights function
Out	Driving lights status	Light switch > Footwell module	Trailer lighting ON/OFF (trailer module)
Out	Direction indicator	Turn-signal/high-beam switch > Footwell module	Direction indicator ON (trailer module)
Out	Direction indicator status	Turn-signal/high-beam switch > Footwell module	Synchronization flashing signal (e.g. display in the instrument cluster)

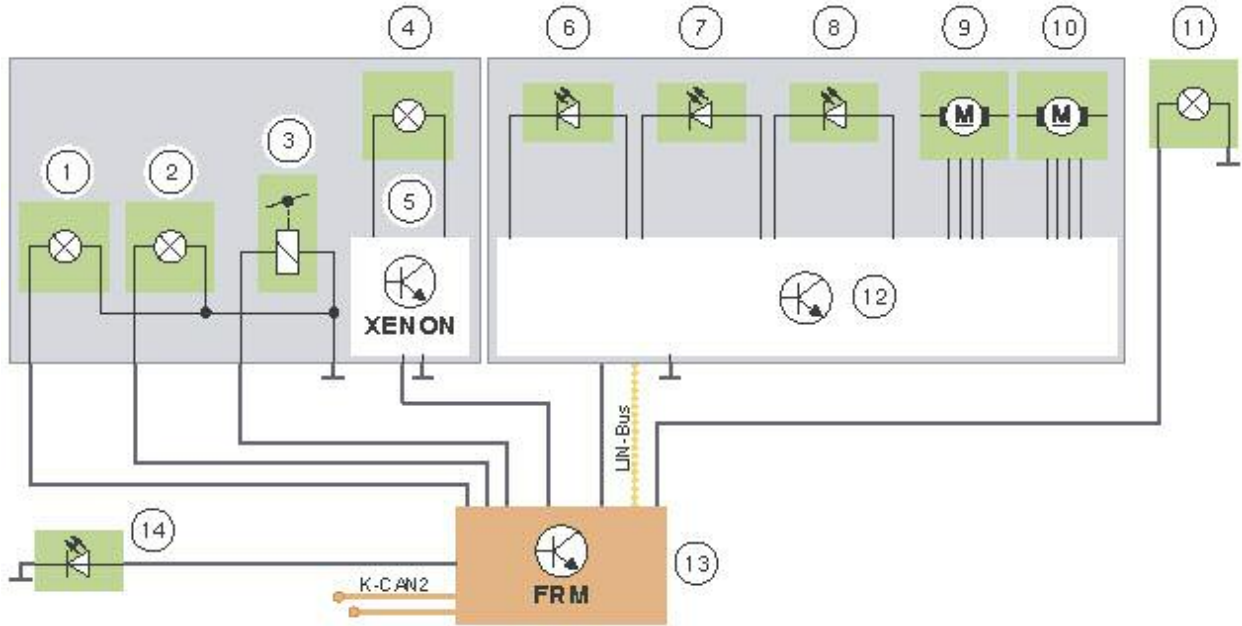
The lights control panel (15) includes:

- Light switch
- Fog light button
- Rear fog light button
- Thumbwheel, instrument lighting.

The steering column switch cluster (15) includes:

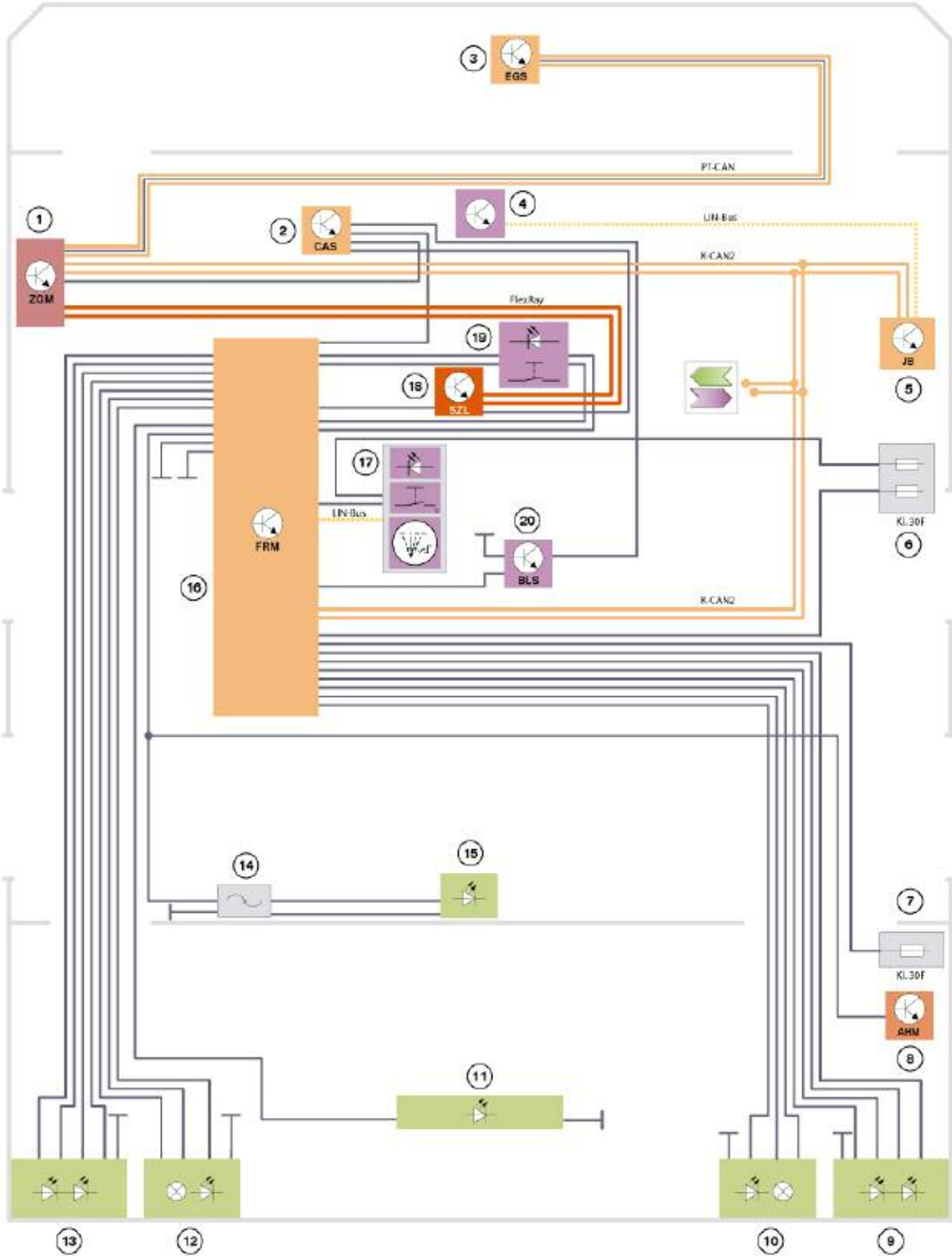
- Steering column stalk, turn-signal/highbeam switch
- Button for automatic driving lights control on wiper steering column stalk.

Illumination, Front



Index	Explanation	Index	Explanation
1	Turning light	8	Design light
2	Side lights/daytime driving light	9	Stepper motor, headlight vertical aim control
3	High beam shutter, bi-xenon	10	Stepper motor for adaptive headlight
4	Bi-xenon lamp for driving light / high-beam headlight	11	Fog lights
5	Xenon ballast	12	Headlight driver module
6	Side marker light	13	Footwell module
7	Direction indicator lights	14	Direction indicator repeater, left

Schematic Circuit Diagram - Exterior Lighting System, Rear



Index	Explanation	Index	Explanation
1	Central gateway module (ZGW)	14	Filter with trap circuit
2	Car Access System (CAS)	15	Additional brake light
3	Electronic transmission control (EGS)	16	Footwell module (FRM)
4	Rain/driving lights/condensation/solar sensor *	17	Control panel, light switch
5	Junction box electronics (JB)	18	Steering column switch cluster (SZL)
6	Power distribution box, front	19	Hazard warning switch
7	Power distribution box, luggage compartment	20	Brake light switch
8	Not for US	PT-CAN	Powertrain CAN
9	Outer rear light cluster, right	K-CAN2	Body CAN2
10	Inner rear light cluster, right	FlexRay	FlexRay
11	License plate light	LIN-Bus	Local interconnect network bus
12	Inner rear light cluster, left	KI. 30F	Terminal 30, fault switched
13	Outer rear light cluster, left		

The rear light clusters (9 and 13) include:

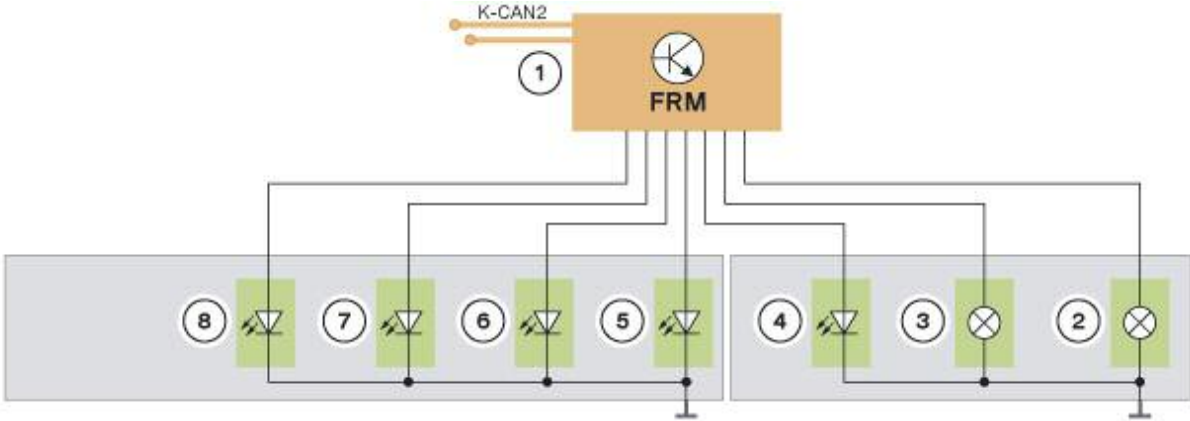
- Brake light
- Direction indicator lights
- Tail lights
- Side marker light.

The rear light clusters (10 and 12) include:

- Brake light
- Reversing light
- ail lights
- Adaptive brake light, US version.

Illumination, Rear

Rear light cluster, left



Index	Explanation	Index	Explanation
1	Footwell module (FRM)	6	Brake light 2
2	Reversing light	7	Brake light 1
3	Rear fog light/ brake force display	8	Direction indicator lights
4	Tail light 2	K-CAN2	Body CAN2
5	Tail light 1 including side marker light		

Functions

Overview

The functions of the exterior lighting are integrated in the footwell module.

These lighting functions are:

- Side lights
- Low beam headlight
- High-beam headlight
 - Headlight flasher
- Fog light
- Direction indicator light
 - Hazard warning light
- Tail light/license plate light
- Dynamic brake light
- Reversing light
- Parking lights
- Welcome light
- Delayed switch-off home lights
- Daytime driving light.

The headlight lighting functions are powered via a headlight driver module or the footwell module.

The footwell module controls a constant brightness level for each headlight. This is achieved with a pulse-width regulated voltage supply. Voltage fluctuations in the vehicle electrical and bus systems are compensated for by the pulse width.

The headlight driver module receives the information on the voltage supply for its light source via the LIN bus.

Note: The LEDs, e.g. in the additional brake light, tail light or bi-xenon headlight are not controlled but rather activated at 100 % pulse width.

In addition to the standard light functions, further functions for the exterior lighting are integrated in the footwell module:

- Dynamic beam throw adjustment system
- Lamp monitoring
 - Cold monitoring with lights “OFF”
 - Hot monitoring with lights “ON”
- Visual alarm/feedback
 - Central locking system
 - Antitheft alarm system
 - Crash signal
- Special case at “Terminal 15 OFF”
- Emergency operating mode
- Adaptive headlight with
 - Turning lights
 - Adaptive headlight-range adjustment system.

Light Functions

Side Light, Low Beam and High Beam

The exterior lighting system is switched on via the light switch.

The following table shows the terminal setting for switching on the exterior lighting.

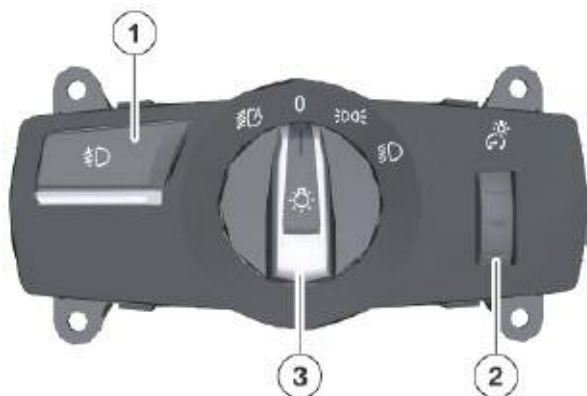
Light function	Activation by	Terminal
Side lights	Light switch, position 1	Terminal 30F ON
Low beam headlight	Light switch, position 2	Terminal 15 ON
High-beam headlight	Briefly press steering column stalk forward	Terminal 15 ON
Headlight flasher	Pull steering column stalk back	Terminal R ON

The control panel contains the light switch for the side lights and low beam headlights as well as the following components:

- Fog light button
- Display for automatic driving lights control
- Thumbwheel for dimming the instrument lighting.

Examples of the lights control panel:

Control panel with automatic driving lights control



Index	Explanation
1	Fog lights
2	Dimmer, instrument lighting
3	Light switch

Side Light

The light switch in the light control unit must be turned to switch position 1 to switch on the side light.

The following lamps are activated together with switching on the side light:

- Daytime driving light corona rings, dimmed on bi-xenon headlights
- Tail lights
- Left/right license plate light
- Terminal 58 switched.

Low Beam Headlight

To switch on the low beam headlights, the light switch in the lights control panel must be turned to low beam headlight (switch position 2) When the low beam headlights are switched-on the bi-xenon headlights are activated.

After turning off the engine, the side lights stay on although the light switch is in switch position 2. The side lights are switched off automatically as the driver's door is opened.

Note: The light switch must be consciously set to switch position 1 in order to make the vehicle more easily detectable by means of the side lights when it is dark.

An audible signal (gong) sounds and the check control message opposite is shown in the instrument cluster as soon as the side lights are switched on. Leaving the side lights switched on can drain the vehicle battery.



High-beam Headlight

The high beam headlight is switched on under following conditions:

- Terminal 15 ON and
- Light switch in position 2 low beam and
- Turn-signal/high-beam switch for high-beam headlight ON.

The headlight flasher is activated by pulling on the turn-signal/high-beam switch. The function is operative as from Terminal 30F ON.

Direction Indicator/high Beam Switch

The steering column switch cluster contains the direction indicator/high beam switch. The signal from the turn-signal/high-beam switch is transmitted from the steering column switch cluster via the FlexRay. The central gateway module transfers the signal to the K-CAN2. The footwell module thus receives the signals from the turn-signal/high-beam switch.

Automatic Driving Lights Control

The following conditions must apply for the low-beam headlights to be switched on:

- Light switch in position A automatic driving light control and
- Status “Terminal 15 ON” and
- Rain/driving lights/solar sensor or rain/light/ solar/condensation sensor signals darkness.

Note: The rain/driving lights/solar sensor has now been extended with the condensation sensor function. It performs the condensation sensor function for the air conditioning system.

Only the rain/light/solar/condensation sensor is used from now on in the description. The description also applies correspondingly for the rain/driving lights/ solar sensor. Both sensors are connected over the LIN bus.

The footwell module switches on the low-beam light if the signal from the rain/light/solar/condensation sensor fails due to a defect.

The low beam lights are switched on together with the side lights by the automatic driving lights control system as soon as the rain/light/ solar/condensation sensor detects a certain level of ambient brightness. The signal is sent from the rain/light/solar/condensation sensor via the LIN bus to the junction box electronics.

The junction box electronics routes the signal via the K-CAN2 to the footwell module. In turn, the footwell module evaluates the signal and switches on the driving lights.

The driving lights switched on by the automatic driving lights control system can be switched off with the light switch or by means of the rain/light/solar/condensation sensor.

The side lights can also remain on after “Terminal 15 OFF” because they were switched on by the automatic driving lights control function. The side lights are switched off automatically after opening the driver’s door.

If a different door is used to exit the vehicle, the side lights will be switched off when the vehicle is locked.

The rain/light/solar/condensation sensor supplies the switch-on signal for the driving lights at a specific level of darkness.

The roof functions center is responsible for the voltage supply to the rain/light/solar/ condensation sensor.

The junction box electronics queries relevant statuses via the LIN bus and transmits them over the K-CAN2.

Fog Lights

Switching Fog Lights ON/OFF

The fog lights can be switched on under the following conditions:

- Terminal 15 ON and
- Light switch in position 1 side lights or position 2 low-beam headlights ON or automatic driving lights control and
- Fog lights button pressed.

The fog lights are switched off by pressing the button again. When switched on, the fog lights can also be switched off by turning the light switch to the “Lights OFF” position.

The fog lights can be switched on again when the light switch is set to the side lights, low beam or automatic driving lights control position.



A H-8 35 W bulb is fitted in each fog light.

Direction Indicator Lights

The front and rear direction indicator light as well as the side direction indicator repeaters can be switched on as from Terminal R ON. They are operated by means of the switch on the steering column switch cluster. The signal from the steering column stalk is transmitted redundantly via the FlexRay and a separate wire. This increases system availability, for instance in the event of faults.

It is nonetheless still possible to use the direction indicators if the information does not arrive at the footwell module via the bus system. This is because the information is available redundantly over the separate wire.

Note: The redundant transmission is also used for the one-touch indicating and headlight flasher functions.

A defective light source in the front or rear direction indicator lights causes the remaining direction indicator lights to flash at double the rate. A defective light source in the front direction indicator repeaters has no influence on the flashing rate of the direction indicator lights.

All direction indicator lights are equipped with LEDs (Light Emitting Diodes).

One-touch Indicating

The direction indicator lights are activated once in connection with one-touch indicating. In the personal profile it is possible to set the one-touch indicating function from flashing once to three times.

Hazard Warning Lights

The hazard warning lights are switched on by pressing the hazard warning switch. As a result, all direction indicator lights are activated simultaneously and the indicator in the hazard warning switch flashes in time.

The steering column switch has priority if it is moved in left or right direction while the hazard warning lights are active. The hazard warning function resumes after "Terminal 15 OFF" or cancelling the direction indicator.

The hazard warning lights have priority when the direction indicator lights for turning left or right are switched on and the hazard warning light switch is pressed.

Hazard warning light switch on the dashboard F01/F02



Index	Explanation
1	Hazard warning switch
2	Central-locking button

Note: At Terminal 30/Terminal 30B ON the hazard-warning lights are switched on with reduced consumption. This means the hazard-warning lights are on for a shorter time and off for a longer time.

Hazard warning lights in connection with alarm triggered by the anti-theft alarm system

The footwell module receives the request for the hazard warning lights via the K-CAN2. The signal is sent by the ultrasonic interior movement detector.

The alarm time for the hazard warning lights is 6 minutes provided the antitheft alarm system is not switched off. The hazard warning light switch is blanked out during the alarm and therefore does not flash together with the lights.

Note: The ultrasonic interior movement detector is completely integrated in the roof functions center, both in terms of hardware and software.

Visual and Audible Indicators

The instrument cluster provides visual and audible indication of the turn signals. The footwell module informs the instrument cluster via the K-CAN2 to activate the acoustic generator and the indicator lights together with the direction indicator lights.

The visual/audible indicator in the instrument cluster switches off if the vehicle is locked with the central locking while the hazard warning light function is active.

Visual Feedback Through the Central Locking

The visual feedback is set at the factory. The direction indicator lights flash when the central locking is activated. The Car Access System makes available the signal necessary for this purpose via the K-CAN2.

The visual feedback can be deactivated in the personal profile.

The antitheft alarm system can also initiate visual feedback for the customer.

Tail Light / License Plate Light

In the same way as the side lights, the tail light can be switched on from Terminal 30F ON together with the license plate light by using the light switch (position 1).

Rear Light Cluster

The rear light cluster of the F01/F02 is based on a split design. One part is integrated in the body and the other in the luggage compartment lid. The two parts form the complete rear light cluster.

The rear light cluster in the body section is fitted with LEDs for the following lighting functions.

- Tail lights
- Brake light
- Direction indicator lights
- Side marker light, integrated in the tail light.

Three lighting functions are integrated in the rear light cluster. They are:

- Reversing lights 16 W
- Brake light (US version “Brake Force Display” - BFD)
- Tail lights based on LEDs.

At Terminal 30 the consumption of the tail lights is reduced by only switching on the tail light in the rear side panel.

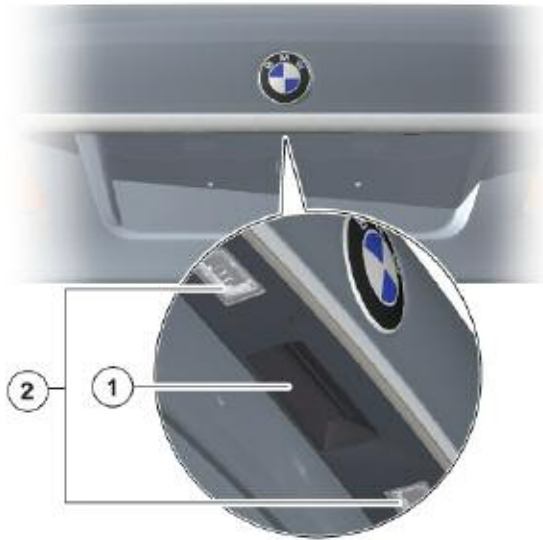
Design of the left-hand two-piece rear light cluster, F01/F02



Index	Explanation	Index	Explanation
1	Reversing light	5	Reflector, side marking
2	Tail light (LEDs)	6	Tail light (LEDs)
3	Brake light in US version (BFD)	7	Direction indicator light (LEDs)
4	Brake light (LEDs, in outside and inside chambers)		

License Plate Light

The license plate light is designed based on LEDs. The LEDs are integrated in the strip handle on the luggage compartment lid. Three LEDs are used for each license plate light.



Index	Explanation
1	L and R License plate lights
2	Trunk release button

Brake Light

As from “Terminal R ON”, the brake lights can be switched on by activating the brake light switch.

The Car Access System powers the brake light switch with 5 V voltage. The footwell module evaluates the status of the brake pedal switch and actuates the brake light. The brake light switch provides two levels.

The signal of the brake pedal switch is also used for the beam throw adjustment (LWR).

Note: The brake light can also be activated by a braking assistant function such as ACC.

Adaptive Brake Light - US

The current adaptive brake light remains in the national-market version US. Braking is indicated by an increase in size and luminous intensity. It is not permissible for the red surfaces of the brake light to flash. The adaptive brake light is part of the standard equipment.

The following conditions must be met for operation of the adaptive brake light:

- Driving speed > 5 kph (3 mph)
- Brake deceleration above 5 m/s² or
- Control intervention by the antilock braking system.

Reversing Light

The reversing light can be switched on as from “Terminal 15 ON”. The footwell module receives the signal via the K-CAN2. The electronic transmission control unit makes available this signal.

When the vehicle is in trailer towing mode, the reversing light of the trailer is additionally activated via the trailer module.

Parking Lights

The parking lights are switched on with the steering column switch as from “Terminal 30” and detected by the footwell module via the KCAN2.

For the parking light function, the footwell module activates the front side lights and the tail light in the outer chamber of the rear light cluster.

The steering column stalk for the parking lights must be pressed for longer than half a second. This prevents the parking lights being switched on by mistake, e.g. by knocking against the steering column switch while getting out of the car.

More Functions

Bi-xenon Headlights

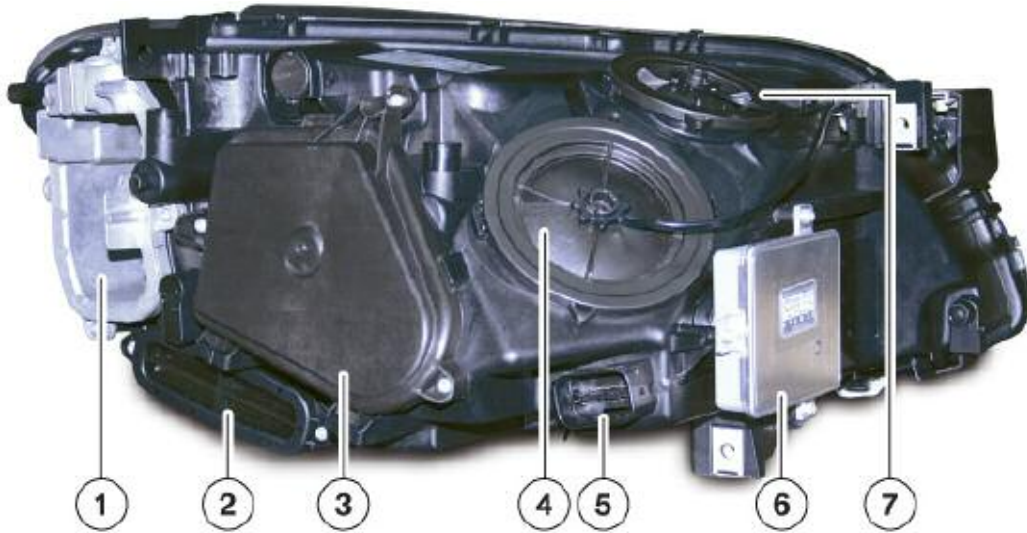
Bi-xenon headlights are installed as standard equipment and are located in the outer chamber of the headlights.

In connection with the bi-xenon headlights, the shutter for the low beam light is activated by the “high beam ON” signal thus enabling the high beam light. High beam is also used for the headlight flasher function



Index	Explanation	Index	Explanation
1	Turning lights	5	Direction indicator lights
2	Bi-xenon low beam/high beam	6	Side lights/daytime driving lights corona ring
3	Position light/daytime driving lights/ design light	7	Side lights/daytime driving lights corona ring
4	Side marker light (US only)		

Bi-xenon headlights F01/F02 viewed from the rear



Index	Explanation	Index	Explanation
1	Direction indicator lights heat sink	5	Headlight connection
2	Headlight driver module	6	Voltage supply for bi-xenon lamp
3	Cover for bi-xenon lamp	7	Cover for lamp, turning lights
4	Cover for lamp, side lights/daytime driving lights corona ring		

Daytime driving lights

A 35 W bulb for the daytime driving light is in the headlight inner chamber. The daytime driving light with respect to the side lights is produced by the inner and outer corona rings. The corona rings are fiber optics conductors.

The inner corona ring is illuminated from behind. The reflector is designed to ensure that the light mainly illuminates the corona ring. Light from the same headlight chamber is coupled in two fiber optics cables and fed to the outer corona ring.

The footwell module decreases the daytime driving lights as soon as the side lights or low beam lights are switched on. Consequently, both corona rings of the daytime driving light are now used for the side lights.

The light switch must be in position “0” in order to activate the daytime driving lights.

The daytime driving lights are also switched on at low beam OFF with automatic driving lights control. The light switch must be set to position “A”.

The daytime driving lights function is country-specific and is activated as from “Terminal 15 ON”. The daytime driving lights can be deactivated/activated via the personal profile.

The daytime driving lights are switched off after “Terminal 15 OFF”.

Note: The daytime driving lights cannot be deactivated in the personal profile in the US version. The daytime driving lights can also be activated in light switch position 1 side lights.

Welcome Light

The welcome light can not be activated when the light switch is in position “0” or “1”. Furthermore, the side lights are also not to be activated.

The welcome light is switched on as soon as the vehicle is unlocked. For this purpose, the Car Access System makes available the status of the central locking system via the K-CAN2.

The footwell module receives the “Unlock vehicle” status and switches on the exterior lighting for approximately 20 seconds.

While switched on, the welcome light can be deactivated with the “Terminal 15 ON” status.

The following light units are activated:

- Tail lights
- Corona rings
- Side marker light
- Interior lighting
- Courtesy lighting
- Indicator light in the instrument cluster.

Delayed Switch-off Home Lights

The delayed switch-off home lights are standard equipment. The lights can be switched on via the steering column switch for high beam as from lights OFF, at Terminal 30.

The switch-on time is set at the factory to 40 seconds and can be set between 0 and 240 seconds in the “Personal Profile”.

The low beam, side lights and tail lights are switched on when the home lights function is active.

Beam Throw Adjustment System

The F01/F02 has a dynamic beam throw adjustment system in the standard equipment. The dynamic beam throw adjustment system is a legal requirement for bi-xenon light. The dynamic beam throw adjustment ensures that oncoming traffic is not dazzled.

One ride-height sensor is installed at the front and one at the rear for the beam throw adjustment system.

■ Front and rear ride-height sensors

One ride-height sensor is mounted on the front axle and the other ride-height sensor on the rear axle of the vehicle. The signals from the ride-height sensors are used for the beam throw adjustment LWR.

The ride-height sensors are evaluated directly by the integrated chassis management. The footwell module receives the signals from the integrated chassis management via the KCAN2. In the central gateway module the signal must be transferred from the FlexRay to the K-CAN.

Lamp Monitoring

The footwell monitors all lamps of the exterior lighting system both when switched on and when switched off. The monitoring function starts as from “Terminal 15 ON”.

■ Cold monitoring with “Lights OFF”

Cold monitoring is based on measuring the current of the individual lamp outputs. The current pulse used for measurement purposes is so short that the lamps are not illuminated. The footwell module evaluates the individual lamp outputs to establish whether there is a line break or a lamp bulb is defective.

The number of current pulses is increased significantly during the first 4 seconds after “Terminal 15 ON”. To check whether the lamps are in working order before setting off. This function is referred to as the pre-drive check.

The number of pulses is then reduced after the pre-drive check. Power is then applied to the lamps every 1.5 minutes.

The lights fitted with LEDs are not included in the cold monitoring system. The LEDs react too fast to the current pulse and would consequently light up.

The bi-xenon headlight is also not included in the cold monitoring.

■ Hot monitoring with “Lights ON”

Hot monitoring is based on measuring the current of the individual lamp outputs. The lamp current is used to detect an overcurrent or interruption (break). The front and rear direction indicator lights are also included in the lamp monitoring system.

Visual Alarm/feedback

■ Central locking system

The Car Access System outputs signals for the central locking system function. The footwell module also receives the signals via the K-CAN2 and uses them for visual feedback of the central locking system.

■ Antitheft alarm system

The footwell module enables the antitheft alarm system to trigger the visual alarm via the direction indicator lights.

The roof functions center with integrated ultrasonic interior movement detector makes available the signal for the visual alarm via the K-CAN2. Furthermore, the footwell module receives the signals from the roof functions center for visual feedback of the antitheft alarm system.

■ Crash signal

The footwell module switches on the hazard warning lights and the interior lighting when the crash safety module sends a crash signal. The hazard warning lights can be switched off with the hazard warning light switch.

The light in the hazard warning light switch is switched off by pressing the light switch to position 0 "Lights OFF" or by means of the rocker switch on the steering column stalk.

Special Case at "Terminal 15 OFF"

The exterior lighting would be switched off if "Terminal 15 ON" fails during vehicle operation or Terminal 15 is inadvertently deactivated by pressing the START-STOP button.

The driving lights remain switched-on in order to maintain road safety in this situation.

When the driving speed drops below 20 kph (12 mph), the low beam light is also switched off after a delay of approximately 30 seconds.

Emergency Operating Mode

Emergency operating mode is assumed if a defect occurs in the software of the footwell module that could cause failure of the entire exterior lighting system. In this case, the tail lights and the additional brake light are activated. This function is active as from "Terminal 15 ON".

Driving lights: Low beam headlight and one tail light on each side

Brake lights: Additional brake light and one tail light on each side

Adaptive Headlight

Adaptive headlight are an option and include the following functions:

- Adaptive headlight
- Turning lights
- Variable headlight beam pattern
- Adaptive headlight-range adjustment system.

The adaptive headlight were introduced with the E60. The F01/F02 therefore also includes, for instance, the functions variable headlight beam pattern or turning lights.

Furthermore, the adaptive headlight-range adjustment system is an additional function.

The light switch must be in the automatic driving lights control position.

Legal Regulation

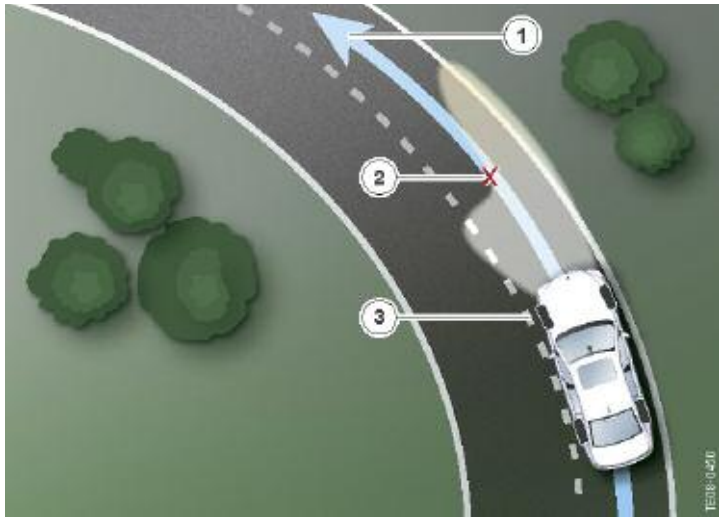
Panning of headlights for the adaptive headlights is permitted within certain limits. An important point is that oncoming traffic is not to be dazzled by the headlights.

When the driver turns the steering wheel the vehicle moves on a circular track. The circular track is defined by movement of the wheels and the angle setting of the front wheels.

In order to avoid dazzling oncoming traffic, the break point of the headlight cut-off line must not lie on the left of the circular track within the distance of 100 times the headlight installation height.

The statement for the cut-off line refers to driving on the right. For driving on the left the statement for the cut-off line is mirror-symmetrical.

Break point cut-off line for the F01/F02



Index	Explanation	Index	Explanation
1	Estimated circular track	3	Steering angle
2	Cut-off line break point		

Preconditions for the Adaptive Headlight

To ensure its operability, the adaptive headlight must be adapted to the vehicle-specific data. The vehicle-specific data are located in the footwell module and in the headlight driver modules.

The footwell module contains the data:

- Vehicle identification number
- Vehicle type.

The headlight driver modules contain the data for:

- Headlight and headlight swivel range
- Permitted acceleration and deceleration ramps
- Characteristic speed maps
- Encoding
- Vehicle identification number
- Vehicle type.

The footwell module has the central responsibility for the adaptive headlight function. The entire software for the adaptive headlight is therefore located in the footwell module.

The footwell module is connected via the LIN bus for communication with the headlight driver modules.

The footwell module requests the current headlight status. The footwell module sends the requests necessary for panning the light from the headlights to the headlight driver modules via the LIN bus.

The footwell module is also still connected to the vehicle electrical and bus systems via the K-CAN2. Signals important for the function of the adaptive headlights are received by the footwell module via the K-CAN2.

The table below lists those control units that provide input signals.

Control unit	Signal
Car Access System	Wake-up
Dynamic stability control	Vehicle speed and yaw rate
Rain/light/solar/condensation sensor	Switch on lights when dark
Integrated Chassis Management	Vehicle level

Bi-xenon Headlight

Each bi-xenon headlight contains following components:

- Bi-xenon control unit
- Swivel module for bi-xenon headlight
- Stepper motor for headlight vertical aim control
- Side light corona/daytime driving light corona
- Direction indicator lights
- Design light
- Side marker light
- Headlight driver module.

Bi-xenon Control Uunit

The bi-xenon control unit is located on the bi-xenon headlights. It supplies the power and ignition voltage for the bi-xenon light bulb.

■ Swivel module for bi-xenon headlight

Among other things, the swivel module contains following components:

- Bi-xenon lamp
- Hall sensor for zero position
- Stepper motor.

The bi-xenon light bulb is integrated in the swivel section of the adaptive headlight. The zero position Hall sensor registers the zero position of the swivel module.

The stepper motor provides the swivel movement of the swivel module. A separate stepper motor is installed for the headlight vertical aim control.

The headlight driver module controls and monitors the movement of the stepper motors for the adaptive headlights and the vertical aim control system.

■ Side lights/daytime driving light

The side lights/daytime driving light is designed as a fiber optics light guide ring. A 35 W bulb (H8) supplies the light to the fiber optics ring from below.

Switch-on Conditions

The adaptive headlight can be activated as from terminal status “Terminal 15 ON”.

The rain/light/solar/condensation sensor sends the request to switch on the low beam headlights as soon as it detects low light levels (darkness). Initially, the footwell module switches on the headlight driver modules. The adaptive headlight is ready for operation following a reference run of the bi-xenon headlights.

Note: A reference run is performed during every new start.

The conditions for switching on the adaptive headlight are:

- “Terminal 15 ON”
- Light switch in automatic driving light control position
- Rain/light/solar/condensation sensor detects darkness
- Both bi-xenon headlights are intact.

Note: The footwell module detects a defective bi-xenon headlight by measuring the intake current of the respective bi-xenon headlight.

Switching on Adaptive Headlight

The adaptive headlight is switched on as soon as the rain/light/solar/condensation sensor sends the switch-on signal for the low-beam headlight.

Function Indicator

The low beam headlight and the headlight vertical aim control remain active in the case of fault. The swivel function of the bi-xenon modules is deactivated. A Check Control message is output on the instrument cluster.

Reference Run

In order to determine the zero position, the adaptive headlight performs a reference run depending on the current position of the swivel module.

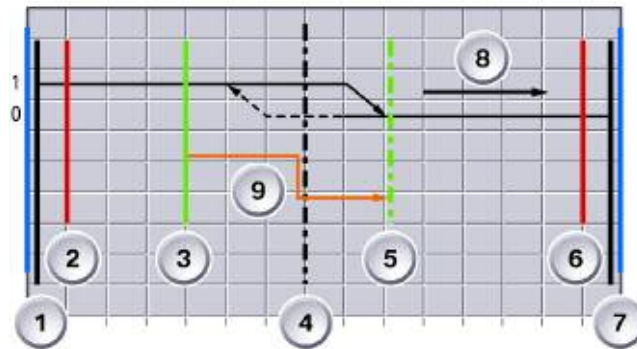
To avoid a hysteresis during calibration, the swivel module always moves from the same side over the zero position sensor.

This is achieved in that the swivel module is always moved to the same side of the zero position sensor before switching off the adaptive headlight.

Zero Position Sensor

The zero position of the swivel module with respect to the zero position sensor is detected by a 1/0 edge when swivelling from the direction of the off position in the direction of the optical axis. The swivel module is repeatedly calibrated during operation based on this “soft” reference point.

Zero position sensor



Index	Explanation	Index	Explanation
1	Mechanical stop, minimum	6	Electrical stop, maximum
2	Electrical stop	7	Mechanical stop
3	OFF position	8	Swivel direction
4	Position of zero position sensor	9	Reference run from left
5	Position of optical axis = 0		

Driving the stepper motor in positive direction of the swivel module corresponds to swivel movement to the right.

Mechanical Stop

Items 1 and 7 represent the mechanical stops of the swivel module. The mechanical stops are defined by the design of the headlights.

Differential Angle

A differential angle is required when the position of the swivel module is not known. A reference run that extends to the mechanical stops must be performed for this purpose. This is known as a “hard” reference run.

Optical Axis

The swivel position, in which the swivel module is in the straight-ahead direction of the vehicle is referred to as the optical axis. An angle of 0° is assigned to this position.

The optical axis is defined exactly as an angle with respect to the zero position sensor and as an angle with respect to the mechanical stop.

Consequently, the optical axis during swivel movement can be “normally” determined by way of the zero position sensor.

The differential angle with respect to the mechanical reference point is used in the case of fault.

Swivel Range

Normally, the swivel module does not move to the mechanical stop but rather to the electric minimum and maximum stops.

Adjustment of the swivel module to the electrical stops avoids the loss of pulses on reaching a mechanical stop.

The minimum and maximum electrical stops are defined as angles with respect to the zero position.

Note: The panning ranges define the maximum pan angles that the adaptive headlights can utilize.

■ Panning, raising and lowering headlights

Via the LIN bus the footwell module instructs the headlight driver modules to actuate the respective stepper motors.

The headlight driver modules activate the stepper motors for panning. For the variable headlight beam pattern, the headlight driver modules also actuate the stepper motors to raise or lower the headlights. The maximum adaptive headlight panning range must not be exceeded when cornering. This must also be considered for the variable beam pattern headlights.

The off-side headlight requires a certain outward pan angle combined with a certain amount of lowering according to the headlight beam pattern.

The outward pan angle must be subtracted from the adaptive headlight pan angle for left-hand bends.

The table below shows which headlights are moved to set the various headlight beam patterns. The first example illustrates the situation for movement when driving in a straight line.

Driving in a straight line, left-hand drive vehicle

Light function	Off-side headlight	Near-side headlight
Urban beam pattern	Pan approximately 12° outwards and lower slightly by approximately 0.7°	---
Single-carriageway beam pattern	Basic beam pattern	Basic beam pattern
Fog light	Pan approximately 8° outwards and lower slightly by approximately 0.7°	---
Highway beam pattern	Pan approximately 3.5° outwards and lower slightly by approximately 0.25°	Raise slightly by approximately 0.2°
High beam	Single-carriageway beam pattern and main beam	

The angles quoted relate to headlights in the straight-ahead position!

■ Example for left-hand bend:

When the urban beam pattern is active, the off-side headlight pans approximately 12° outwards. At the same time, the headlight is slightly lowered. Since, a panning range of up to 15° is available for left-hand bends, only 3° more is left for corner illumination.

■ Example for right-hand bend:

When the urban beam pattern is active, the off-side headlight pans approximately 12° outwards. At the same time, the headlight is slightly lowered. For a right-hand bend a panning range of 8° is available. The headlight pans the full 8° .

Traverse Rate

The traverse rate of the swivel modules is up to $30^\circ/\text{second}$.

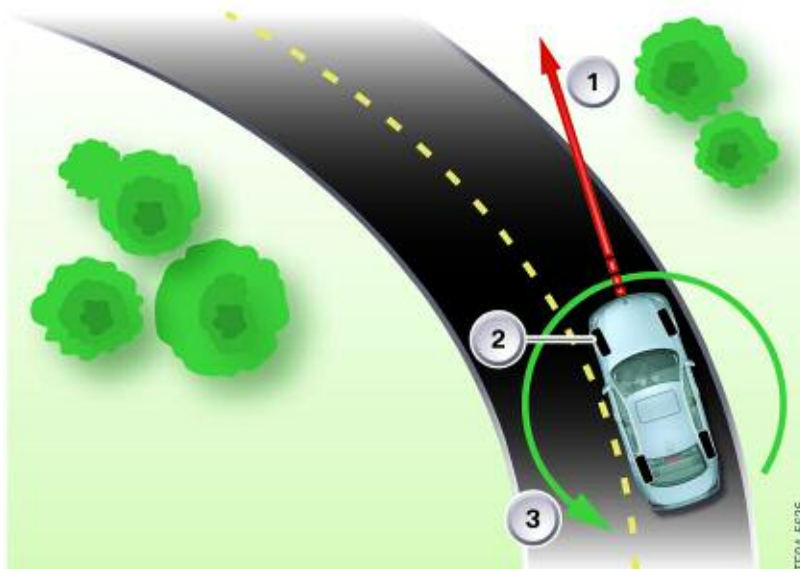
Swiveling

The following signals are made available to the footwell module for the purpose of moving the swivel module.

- Steering angle
- Road speed
- Yaw rate.

Under normal driving conditions, the adaptive headlight is controlled by the data from the steering angle sensor up to a speed of approximately 40 kph (25mph).

Input signals in the E90



Index	Explanation	Index	Explanation
1	Vehicle speed	3	Yaw rate
2	Steering angle		

The yaw rate sensor is included in the calculation

- at speeds higher than approximately 40 km/h (25 mph)
- in the event of vehicle oversteering or understeering
- a vehicle tending to yaw.

The wheel speed sensors supply the signals for the vehicle speed. The dynamic stability control evaluates the wheel speed sensor of each wheel.

The vehicle oversteering/understeering or yawing is detected by means of the steering angle sensor and the yaw rate sensor.

The adaptive headlight is deactivated in the event of the vehicle oversteering/ understeering or yawing. The swivel module returns to its zero position.

Note: The yaw rate sensor makes available signals relating to the yaw of the vehicle about the vertical axis. It is installed between the driver's and front passenger seats on the transmission tunnel.

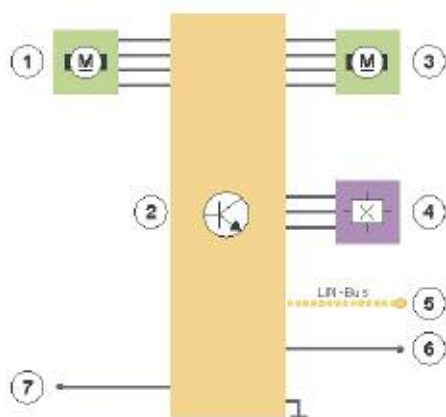
The steering angle sensor is integrated in the steering column switch cluster. It is an optical sensor and makes available data relating to the steering wheel lock angle.

Headlight Driver Module

The headlight driver module controls and monitors the stepper motors for the adaptive headlights and the headlight beam throw adjustment system of the respective bi-xenon headlight.

The integrated chassis management makes available the values for the dynamic headlight beam throw adjustment system to the footwell module. The footwell module receives these values via the K-CAN2. In this way the beam angle can be adapted to the different driving situations, e.g. laden/unladen.

The signal from the integrated chassis management must be transferred to the KCAN2 in the central gateway module.



Index	Explanation
1	Stepper motor for adaptive headlight
2	Headlight driver module
3	Stepper motor, headlight vertical aim control
4	Zero position sensor
5	LIN-Bus
6	Coding pin for right/left
7	Voltage supply +

The headlight driver module fulfils the following functions:

- Receiving and evaluating the data sent from the footwell module via the LIN-bus:
 - Reference run
 - Target position commands
 - Diagnosis requests
- Output control of the stepper motors
- Zero position acquisition of swivel module
- Reference run of swivel module
- Position feedback of swivel module to footwell module
- Diagnosis
- Feedback of diagnosis data to the footwell module.

The footwell module in its function as the central control unit for the adaptive headlight checks the status of the headlight driver modules every 20 ms.

Furthermore, the footwell module initiates activation of the LEDs in the front headlights.

Zero Position of Swivel Module

The zero position of the swivel module is determined by the zero position sensor. The zero position sensor is a Hall sensor. The falling edge of the Hall sensor is evaluated to determine the zero position. The zero position corresponds to exactly the position of the swivel module in the straight-ahead position of the vehicle.

The headlight driver modules prepare the data for data transfer via the LIN bus. The footwell module requests the data from the headlight driver modules.

**Note: The sensor signal can be read out during diagnosis.
The sensor is defective if no sensor signal is applied.**

Switch-off Conditions



As from “Terminal 15 OFF”, the footwell module sends the request via the LIN bus to assume the rest position of both swivel modules to the headlight driver modules. On reaching the rest position of the swivel modules, the headlight driver modules send a confirmation to the footwell module. The headlight driver modules also activate the side lights function.

Afterrunning Time

The afterrunning time is 2 seconds.

Check Control Message

The Check Control messages below exist for the adaptive headlights and the beam throw adjustment system.

Check control message	Description	Information in central information display
	Beam throw adjustment system	Headlight beam throw Beam throw adjustment system of the headlights faulty. Road illumination not optimum. Possible dazzling of oncoming traffic. Have checked by your BMW dealer as soon as possible.
	Adaptive headlight failure	Adaptive headlights. Adaptive headlight failure. Have checked by your BMW dealer.

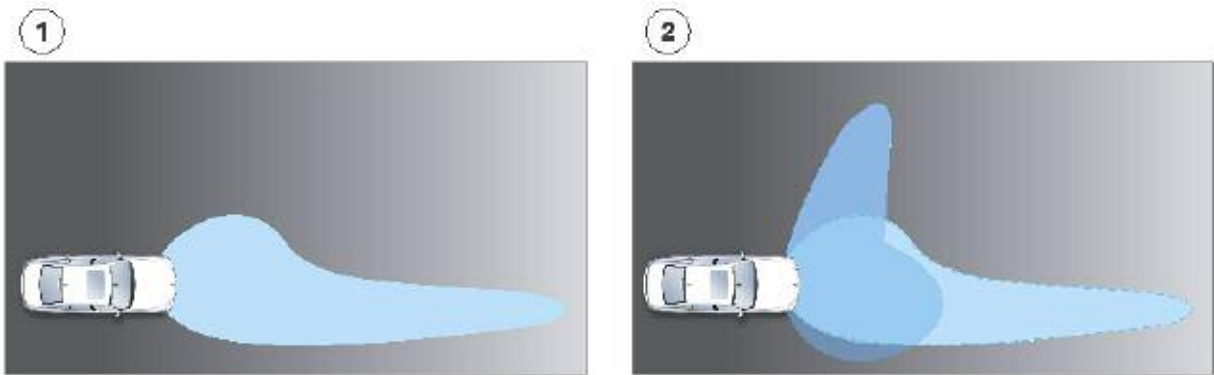
Turning Lights

The turning light function is available only in connection with the option Adaptive Headlight. In addition to the adaptive headlights, the turning light additionally illuminates the area in front of and beside the vehicle.

The turning light makes it possible to recognize persons or traffic situations earlier in the turn-off area.

Parameters such as the steering angle and vehicle speed are taken into account for the turning light function.

Fundamental illumination with the turning light F01/F02



Index	Explanation	Index	Explanation
1	Without turning light	2	With turning light

Condition for Switching the Turning Light on and off

The low beam headlight must be switched on by the automatic driving light control function for the turning light to be activated. The turning light is activated only under the following conditions.

Function matrix for activation of the turning light:

Driving direction	Condition	Side with activated turning light
Forward	<ul style="list-style-type: none">• Speed below 40 kph (25mph)• Direction indicator activated.	Same side as activated direction indicator
	<ul style="list-style-type: none">• Speed below 70 kph (43 mph)• Steering lock.	On side in direction of steering lock
Reverse	<ul style="list-style-type: none">• Speed below 40 kph (25mph)• Reverse gear activated• Direction indicator activated.	Same side as activated direction indicator
	<ul style="list-style-type: none">• Speed below 40 kph (25mph)• Reverse gear activated• Steering lock.	Opposite side in direction of steering lock
	Only for US version: <ul style="list-style-type: none">• Vehicle speed below 40 kph (25mph)• Reverse gear activated.	Both sides

Note: The turning light is no longer switched off if only one signal fails, e.g. due to a defect.

The turning light is equipped with an overheating protection. Therefore the turning light may be briefly deactivated when it is used for a long time.

■ US Version

In the US version, both turning lights are switched on when reverse gear is engaged. The turning light can be activated up to speed below 40 kph (25mph).

■ Turning lights at speeds up to 70 kph (43 mph)

In very tight corners with a radius of less than 100 m, the turning light function can now be activated for even better illumination at speeds up to 70 kph (43 mph). This is particularly helpful on switchback roads. The function is activated if the steering wheel is turned to an appropriate angle.

Note: The turning light function can be activated below 40 kph (25 mph) by switching on the turn-signal indicator or turning the steering wheel by an appropriate amount.

Input parameters:

- Headlights switched on by automatic headlights function
- Steering angle
- Road speed
- Light switch in automatic driving light control position.

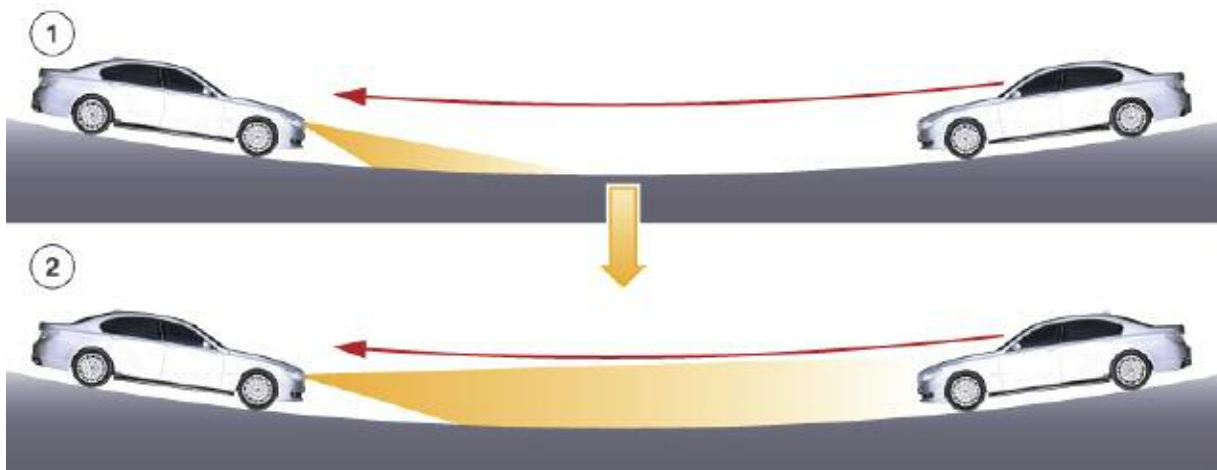
Adaptive Headlight-range Adjustment System

The adaptive headlight-range adjustment system is designed for driving through dips and over crests.

When driving through a dip the headlight beam throw is increased. The headlights are moved up a small amount. The driver can see further and oncoming vehicles are not dazzled. Obstacles on the roadway can therefore be detected earlier than with earlier headlight systems. This allows an early reaction to obstacles and initiation of any evasive action that may be required.

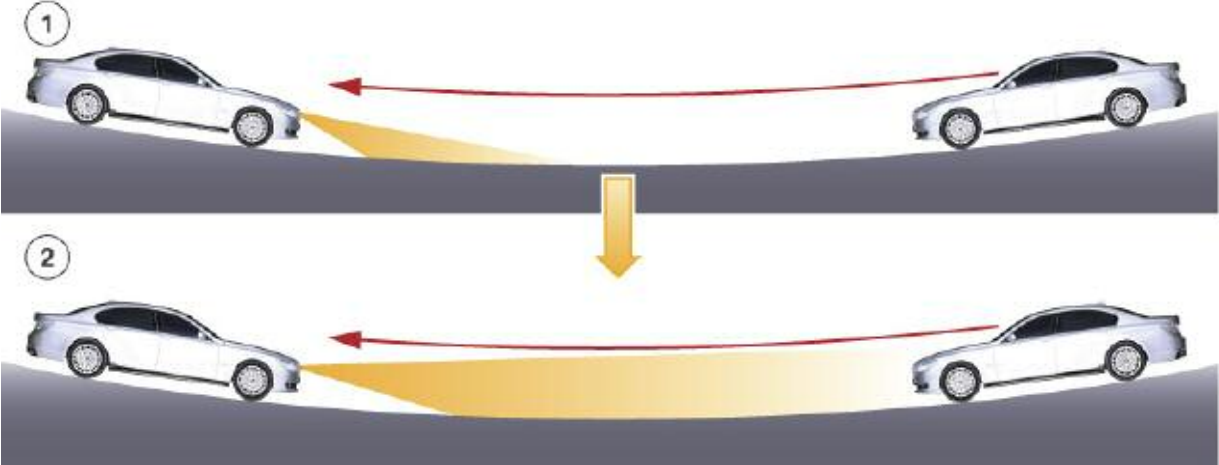
BMW makes an active contribution to safer driving with the adaptive headlight-range adjustment system.

Driving through a dip



When driving over a crest the beam pattern produced by the headlights is slightly lowered. Oncoming vehicles are not dazzled as much as with normal headlights. This contributes towards better road safety.

Driving over a crest



Index	Explanation	Index	Explanation
1	Vehicle without the adaptive headlight-range adjustment system without raising or lowering the headlights	2	Vehicle with the adaptive headlight-range adjustment system, headlights slightly raised or lowered

The red line shows the eye level of the oncoming traffic. The eye level is the location of the eyes when driving through a dip or over a crest.

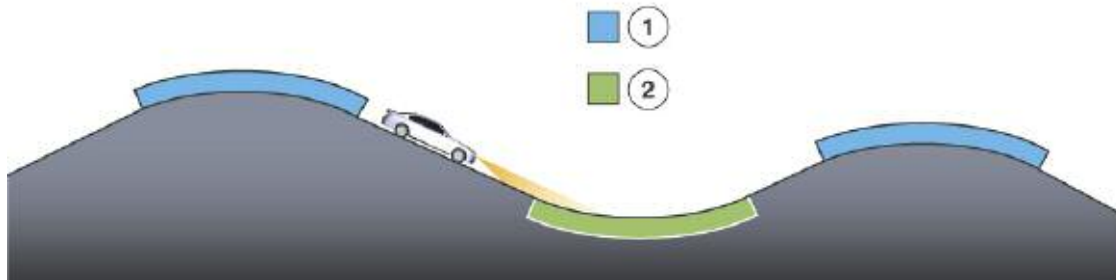
Note: In the figurative sense, the adaptive regarded as being adaptive headlights rotated headlight-range adjustment system can be by 90°.

Dip and Crest

The graphic illustrates the terms dip and crest as they are used in the road traffic engineering field.

Start of a Crest

When driving over a crest data on the incline angle of the crest are needed. Otherwise the crest can not be detected. Therefore the light is lowered with a short delay at the start of a crest.

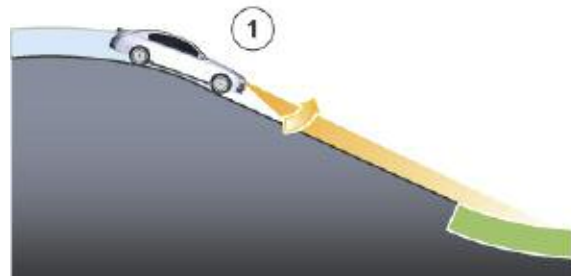


Index	Explanation	Index	Explanation
1	Crest	2	Dip

End of a Crest

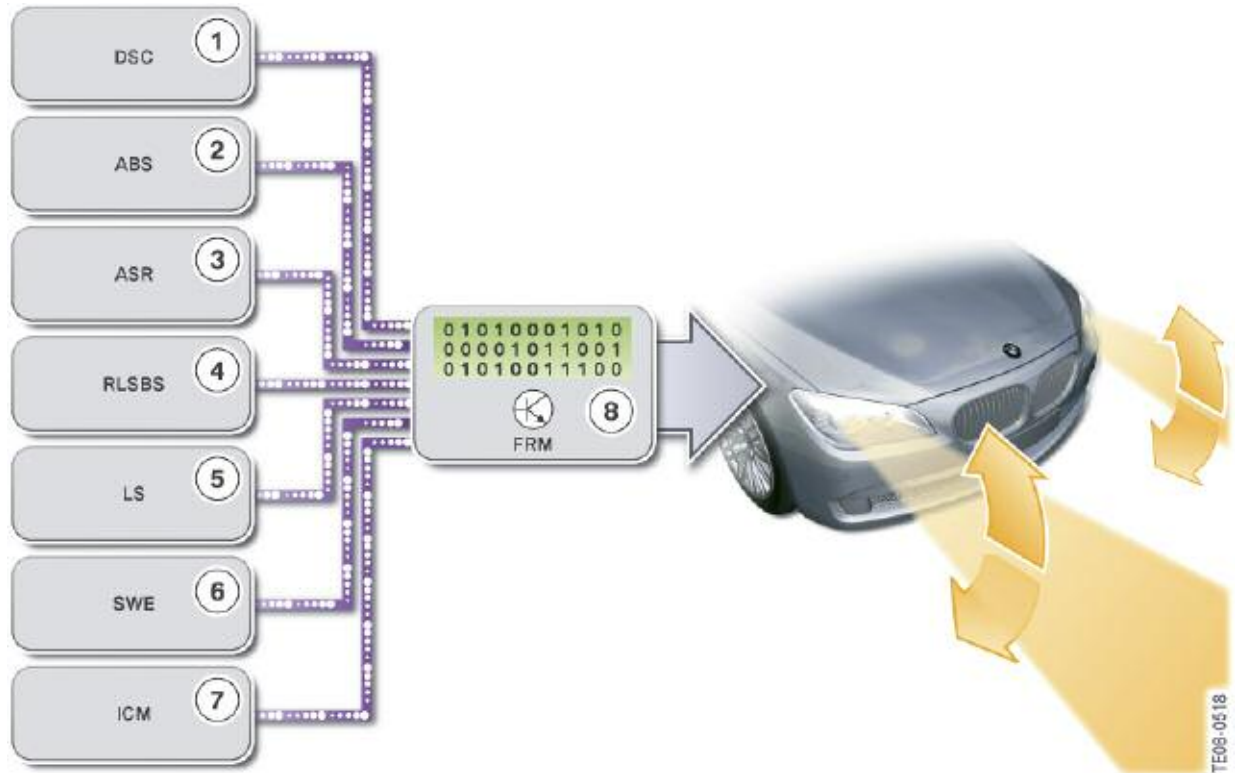
The cumulative negative change to the incline angle is used to detect that the end of a crest is being approached. The headlights are lowered for driving over the crest. If the headlights were to remain in this position the light would illuminate the “ground” after a crest. In order to avoid this situation occurring, the footwell module switches the headlights back to the normal beam angle before the end of the crest.

Vehicle at the end of a crest



Index	Explanation
1	Headlights with normal beam angle at the end of a crest

System Overview



Index	Explanation	Index	Explanation
1	Dynamic Stability Control intervention	5	Light Switch in Position "A"
2	ABS system intervention	6	Poor route detection system
3	Automatic Stability Control intervention	7	Footwell Module (FRM)
4	Rain/light/solar/condensation sensor	8	Headlight activation adaptive headlight range adjustment system

Functional Principle

The adaptive headlight-range adjustment system only becomes active when the light switch is in position "A" and the driving lights have been switched on by the rain/light/solar/ condensation sensor.

Raising or lowering of the headlight beam pattern is based to a great extent upon the calculation of two signals. The signals are the driving speed as well as the longitudinal acceleration of the vehicle. These signals are used to calculate the incline and respectively the downhill gradient compared with the horizon. The footwell module continuously imports the signals via the K-CAN2 and uses them to calculate the current values for the adaptive headlight-range adjustment system. The values correspond to the incline angles over the time period. The incline angles may be positive, negative or zero. The difference between the individual incline angles is used by the footwell module to calculate whether it is necessary to adjust the headlights.

The signal from the ride-height sensors is incorporated into the calculation. This allows the pitch angle of the vehicle body, due to a vehicle load for instance, to be included in the calculation.

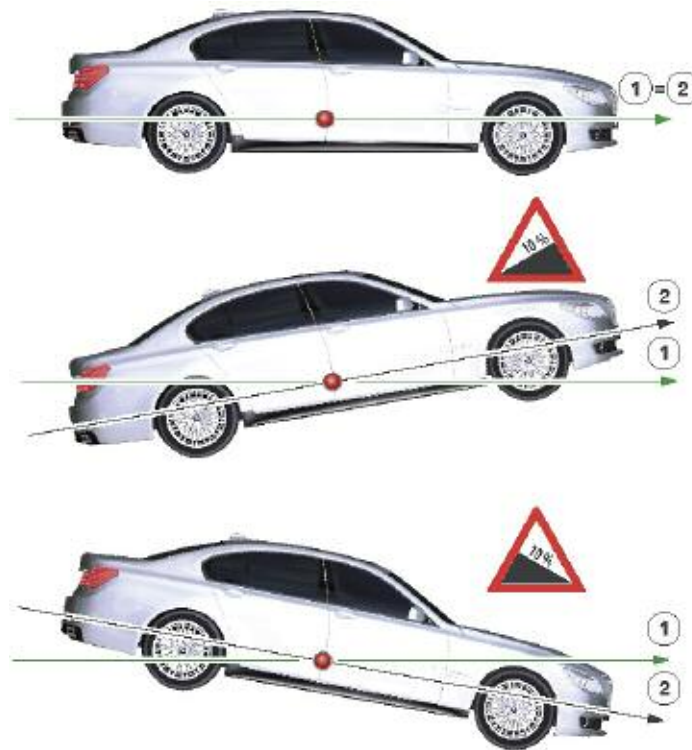
Data from the longitudinal acceleration sensor and the ride-height sensors are output through the integrated chassis management via the FlexRay. Data for the driving speed are provided by the integrated chassis management also via the FlexRay. The central gateway module transfers the data from the FlexRay to the K-CAN2. The footwell module receives the data via the K-CAN2.

Note: The integrated chassis management contains the sensors for the longitudinal and lateral acceleration of the vehicle as well as the yaw rate sensor.

Signals from the wheel speed sensors are registered by the Dynamic Stability Control for the driving speed signal. The Dynamic Stability Control outputs the data to the FlexRay. The integrated chassis management generates the driving speed signal from the data and makes the signal available to the vehicle electrical and bus systems. 1

Beam throw adjustment is soft to avoid the eyes becoming tired or irritated.

Incline angle (±) adaptive headlight-range adjustment system F01/F02



Index	Explanation	Index	Explanation
1	Horizontal axis	2	Positive or negative incline (negative incline is the downhill gradient)

■ Short-term function deactivation

In unfavorable, situations the light emitted by the headlights may be set incorrectly by the adaptive headlight-range adjustment system. One consequence of this could be dazzling of oncoming traffic. Therefore the footwell module interrupts the function for a short time to protect other road users.

The following conditions interrupt the function for a short time:

- Signal from the Dynamic Stability Control
 - Control intervention by the antilock braking system
 - Control intervention by the Automatic Stability Control
 - Control intervention by the Dynamic Stability Control
- Signal from the longitudinal acceleration sensor in the integrated chassis management
 - Very high longitudinal acceleration
- Signal from the footwell module from the dynamic beam throw adjustment system
 - Poor-route detection system signals uneven road.

Remote Light

The Remote Light function is the Vehicle Finder visual signalling. The driving lights are switched on for the signalling.

■ Switch-on conditions

The Remote Light function can be requested via the telematics service provider. The request is only carried out if the battery has not yet reached the limit for starting. The vehicle must be stationary and the engine switched off.

■ Switch-off conditions

Remote Light can be switched off by the following conditions:

- Battery has reached the limit for starting
- Interior light button is pressed
- Change in status of a Hall sensor in the door contacts
- Renewed request Start of a new sequence for the Remote Light function
- Remote Light time expired
- Terminal status change, START-STOP button pressed.

Service Information

Adjusting Headlights

The same procedure as before can be adopted for adjusting the lights. On a vehicle with the adaptive headlights optional extra the light switch must be in position “2”.

If the lights have been switched on by the automatic headlights function, the urban beam pattern will be active. The headlights can only be correctly adjusted when they are set to the single-carriageway beam pattern.

Note: When the lights are set to the urban beam pattern, the off-side headlight turns slightly outwards and is simultaneously slightly lowered. If the lights are adjusted when set to this beam pattern, they will dazzle oncoming traffic when switched to the single-carriageway and highway beam patterns.

Therefore, you should always set the lights switch to position “2”.

When replacing headlights, make sure to use genuine BMW parts only.

Note: It is essential to follow the repair instructions.

Replacing Components

Different repairs may be made during the life of the vehicle. The repairs may mean that components for the adaptive headlights have been installed with different software and hardware states.

New parts and/or used parts are used with the components already installed in the vehicle.

The replaced components must definitely be adapted to the vehicle.

The components below are some of those that could have been replaced during servicing:

- Footwell module
- Headlight driver module
- Bi-xenon headlights.

Footwell Module

Follow the repair instructions when replacing the footwell module. Make sure that only genuine BMW spare parts are used. Only genuine BMW spare parts guarantee correct functioning of the headlights. In the case of a straight swap with a different footwell module there is no guarantee that the replacement will not cause malfunctions in the exterior lighting system.

Diagnosis

Diagnostic Mode

The exterior lighting system must be set to diagnostic mode for different diagnosis orders. These diagnosis orders may be:

- Read out of the relevant bus signals when stationary
 - Road speed
 - Yaw rate
 - Steering angle
- Check of signal plausibility
- Check of switch-on conditions
 - Status of the rain/driving lights/solar sensor
 - Status of the rain/light/solar/condensation sensor
 - Status of the high-beam headlight assistant
 - Status of the light switch.

Missing or non-plausible bus signals are saved in the footwell module as a fault. Fault types are saved in the headlight driver module.

Access to the headlight driver module is achieved via the footwell module.

NOTES

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